A STUDY OF PION AND MUON BEAM TRANSPORT SYSTEMS FOR A 600 MEV SYNCHROCYCLOTRON

Semi-Annual Status Report
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Prepared by:

HERBERT O. FUNSTEN
Associate professor of Physics
College of William and Mary
Williamsburg, Virginia

This status report for grant NsG-636 covers the design of a flexible mounting facility for the pion-muon channel for the Space Radiation Effects Laboratory 600 MeV synchrocyclotron and for a study of the channel's performance. The report covers the period of February 6, 1966 - August 6, 1966.

I. MAGNET SPECIFICATIONS AND FABRICATION

The working drawings for all meson channel magnets have been completed and with review by NASA Langley, have been sent to the AEC fabrication plant in Paduca, Kentucky, which will build the magnets. The meson channel transports pion-muon beams internally generated from the synchrocyclotron to the experimental area, Phase III. Mechanical and electrical details of the specifications for the pion-muon channel magnets and power supplies have been examined extensively in connection with Mr. Draper Smith of NASA, Langley Research Center.

II. MECHANICAL DESIGN OF CHANNEL MOUNTING STRUCTURE

In order to have flexibility in the use of this channel, a mounting arrangement is being engineered which will permit a choice of positive or negative mesons and also a choice of their energy. The mechanical design study for the mounting of the quadrupole channel has been undertaken in connection with Catalytic Construction Company. Preliminary drawings amd specifications necessary to fabricate the mounting assembly have been completed and final engineering design work will be completed within several weeks.

III. POSITIVE PION BEAM SEARCH

In order to test some of the capabilities of the pion detection electronics system and also to ascertain the feasibility of producing an external positive pion beam, a program was initiated to evaluate such a beam using some of the existing external proton beam handling magnets to focus the pion beam.

Several positions of the pion generating target were tried, just upstream of beam monitor 3, in the middle of bending magnet M-6, and just upstream of bending magnet M-7. Initial pion beams from the target were obscured by pions generated by the proton beam hitting a vertical conduit tray in line with and downstream of bending magnet M-6. Additionally, protons scattered and degraded by the pion generating target caused appreciable background in several cases. It was found that the best pion beam was obtained with the pion generating target inside bending magent M-6 at the intersection point of the main proton beam optic axis and the upstream optic axis of bending magnet M-7. With M-6 turned off, M-7 served as a momentum selector taking out degraded protons. The quadrupole magnets downstream of M-6 were then adjusted to point-to-point focusing (focal point being midway between doublets) for 200 MeV/c pions. Using a 6" graphite pion generating target, an optimum positive pion beam was obtained in the proton target room with the characteristics:

Peak-valley ratio	9-1
Mean Momentum	195 MeV/c
Fuel width-half max	14 MeV/c
Flux	around 4 K/sec into 5"x5" counter, full external beam (6μa on BM-2)

At 300 MeV/c pion momentum, the flux is around 30% of the above, at 150 MeV/c, the flux is around 50% of above. A small positive muon component (around .7K/sec) was present additionally.

This work was done with the combined efforts of Dr. R. Siegel, Dr. R. Welsh, Dr. M. Eckhause, Dr. J. Kane of the College. Drs. Stan Sobbotka and Klaus Ziock of the University of Virginia made several independent runs on the $\pi+$ beam.

IV.. INSTRUMENTATION DEVELOPMENT FOR CHANNEL PERFORMANCE MEASUREMENT

Work is currently under way on development of scintillation counter instrumentation for the detection of both positive and negative pion fluxes. For positive pion detection, a counter system detects a stopping pion and the resulting decay 4 MeV muon ($\tau \approx 25$ nanoseconds). Fast circuitry has been employed with < 10 nanoseconds dead time in order to detect the two pulses characteristic of a stopped π^+. For negative pions, pulse height discrimination to select pion capture stars will be used. The π^+ detection instrumentation has been tested with pions externally generated by the extracted proton beam.

The pion flux is somewhat weak ($\approx 10^4$ π^+/sec.) and additional tests are being undertaken on the π^+ detection scheme. It is intended to also obtain a π^- beam using the same arrangement. This beam will be quite low (10^2-10^3 π^-/sec.) but will be adequate for initial testing of the π^- detection apparatus. This program is also in connection with an anticipated.